The First Few Parsecs of the Jets in NGC 4261

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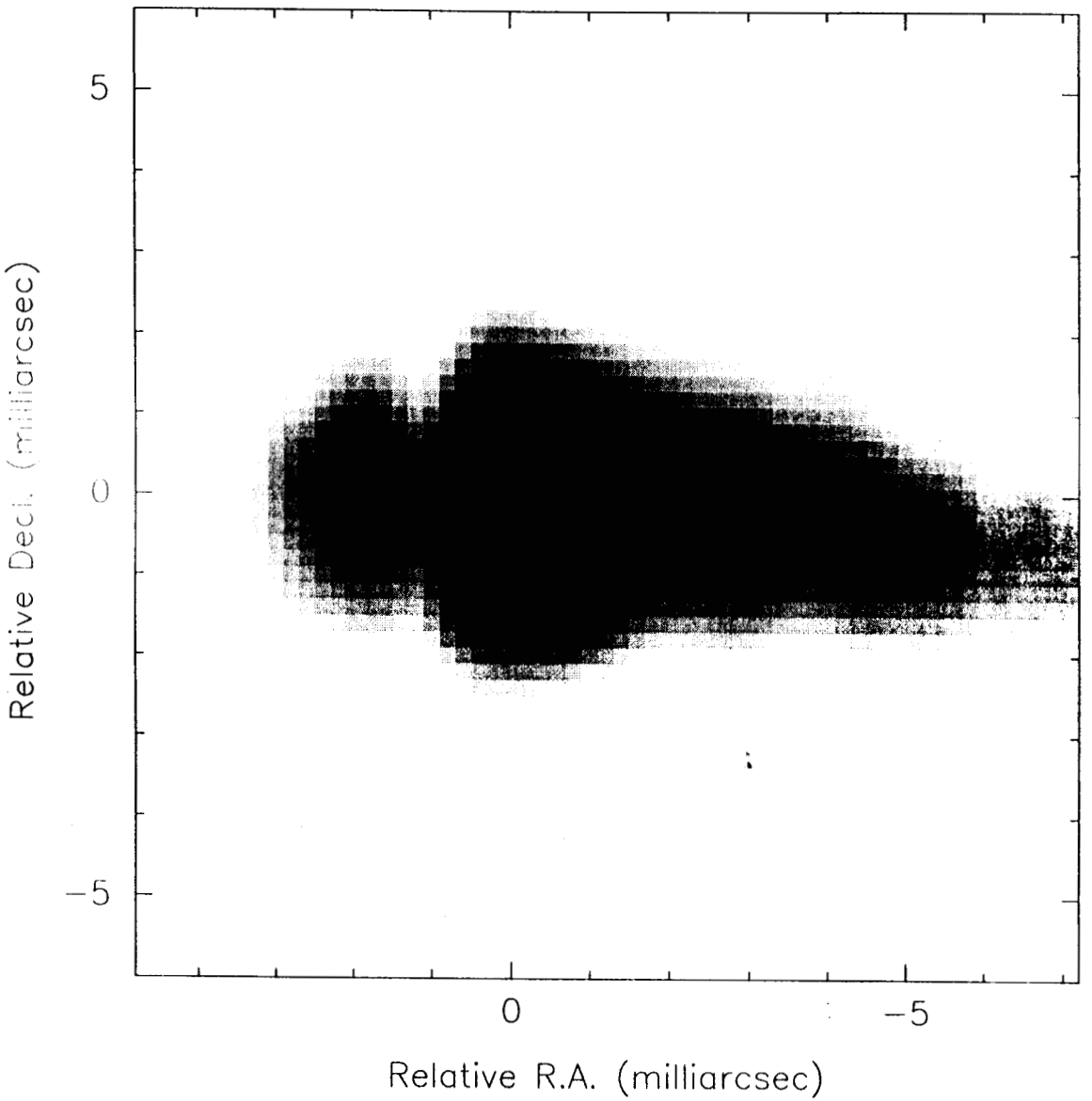
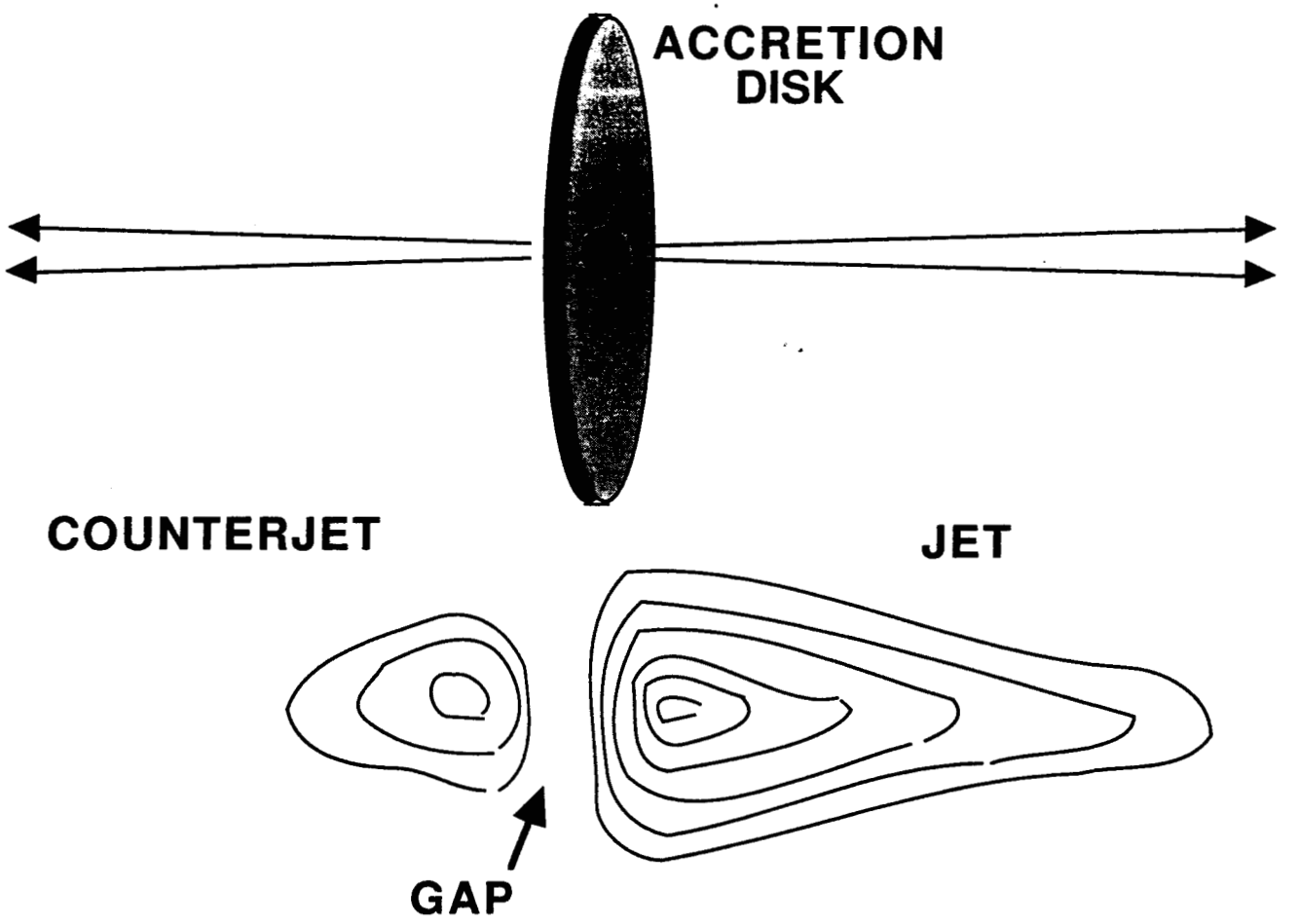
INTRODUCTION

The double-lobed radio galaxy NGC 4261 (3C270) contains a pair of highly symmetric kpc-scale jets, as well as a two-sided morphology on parsec scales. Optical imaging with HST has revealed a large, nearly edge-on nuclear disk of gas and dust. This suggests that the radio axis is close to the plane of the sky and consequently that the relative brightness of the two jets is not significantly affected by relativistic beaming.

Previous Results: Figure 1 below shows our VLBA image of the nuclear compact radio source in NGC 4261. The first 1-2 pc of the (west pointing) jet is seen, along with part of the (east pointing) counterjet and a narrow gap in emission at the base of the counterjet (just east of the brightest peak, which is the core based on its inverted spectrum between 8.4 and 2.3 GHz). A possible interpretation of this morphology is shown below fig. 1.


5
0
−5
Relative Decl. (milliarcsec)
0
−5
Relative R.A. (milliarcsec)

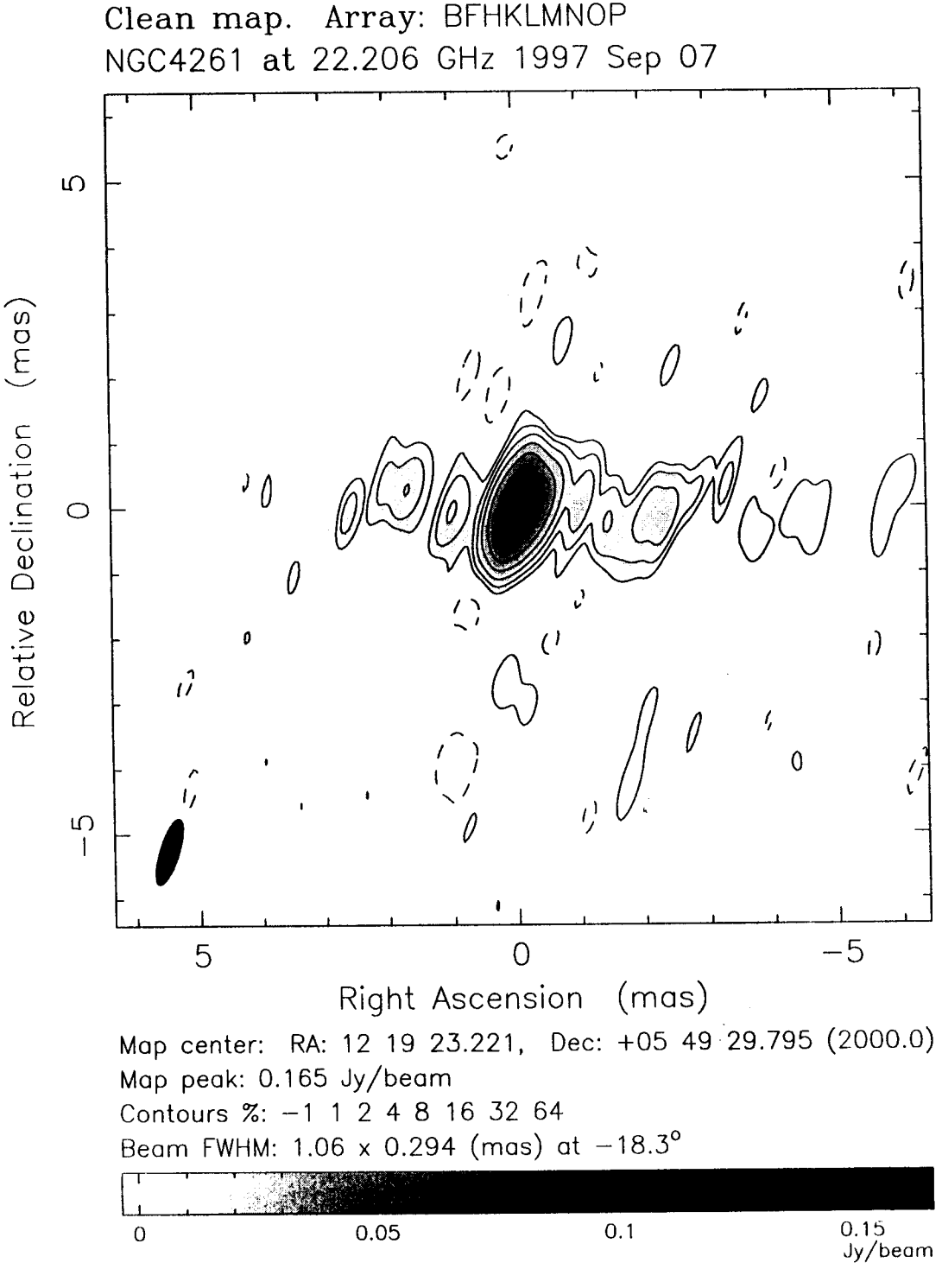

ACCRETION
DISK
COUNTERJET
JET
GAP

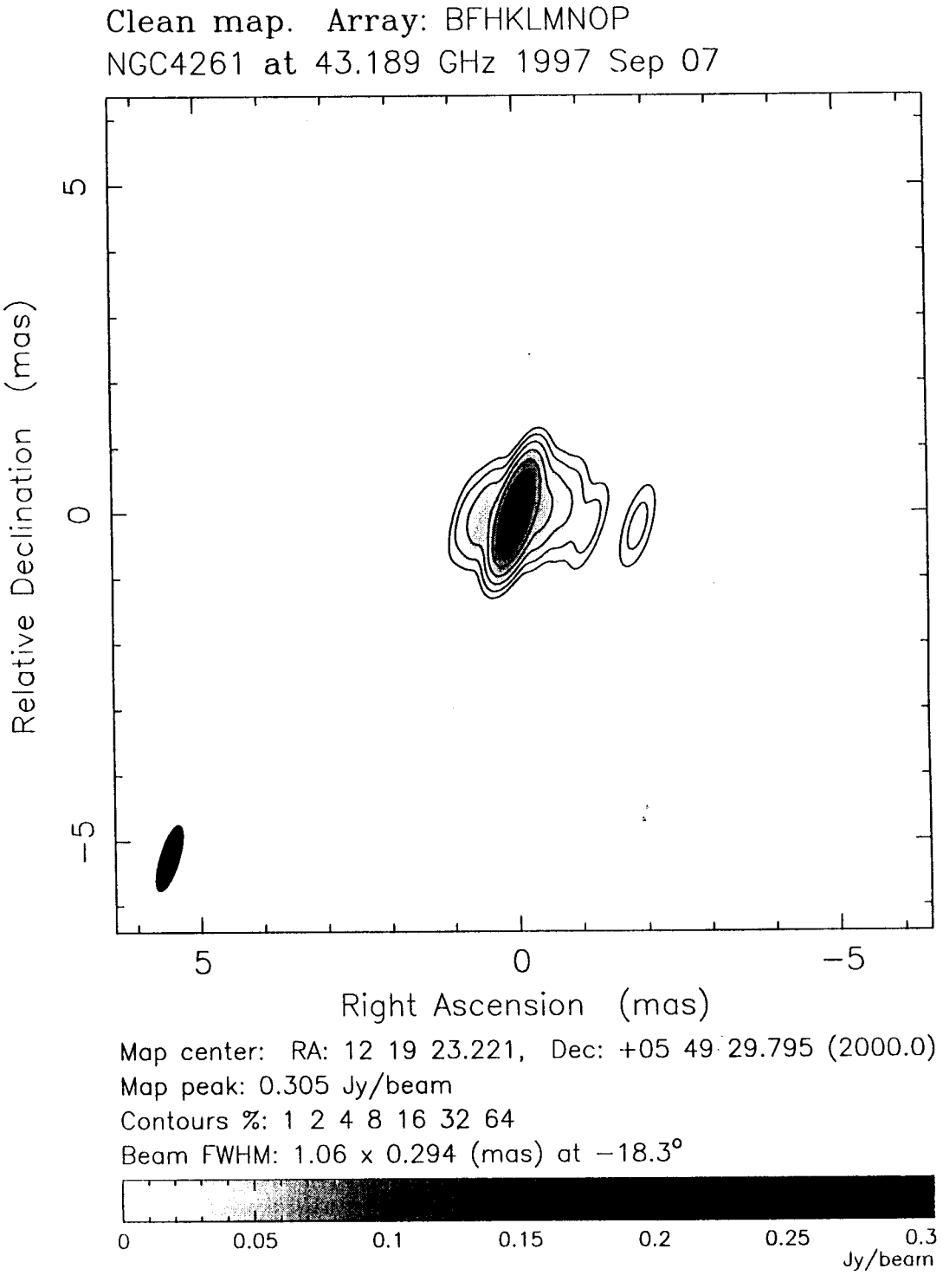
NEW RESULTS

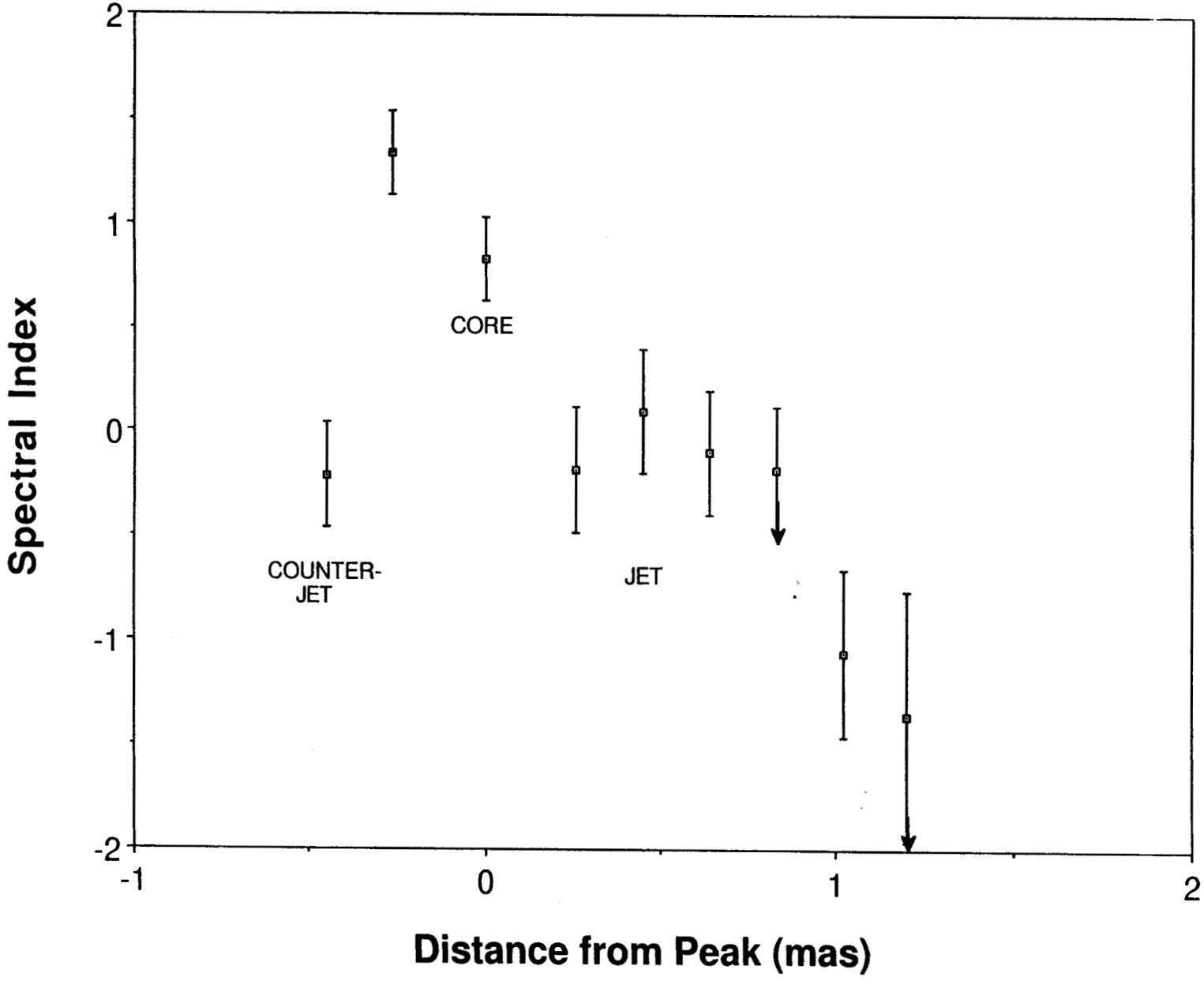
22-GHz VLBA Image: Figure 2 shows the first parsec of the radio jet and counterjet, as well as the bright, barely resolved core. The jet/counterjet brightness ratio +/- 1 mas from the core is smaller than at 8.4 GHz.

43-GHz VLBA Image: The image in fig. 3 has been convolved with the same restoring beam as in fig. 2 to allow spectral indices to be measured. Although only the innermost parts of the jet and counterjet are detectable at this frequency, the brightness ratio is much closer to unity than it is at lower frequencies.

22-43 GHz Spectral Index: Variations in spectral index along the radio axis are shown in figure 4. Uncertainties in the absolute flux scales could shift all of the points on this plot up or down, but will not change the profile of the distribution. Note that the most inverted spectral slope occurs at the position of the presumed accretion disk absorption and not at the position of the bright core.


Clean map. Array: BFHKLMNOP
NGC4261 at 22.206 GHz 1997 Sep 07
Relative Declination (mas)
5
0
−5
5
0
−5
Right Ascension (mas)
Map center: RA: 12 19 23.221, Dec: +05 49 29.795 (2000.0)
Map peak: 0.165 Jy/beam
Contours %: −1 1 2 4 8 16 32 64
Beam FWHM: 1.06 x 0.294 (mas) at −18.3°
0
0.05
0.1
0.15
Jy/beam


Clean map. Array: BFHKLMNOP
NGC4261 at 43.189 GHz 1997 Sep 07
Relative Declination (mas)
5
0
−5
5
0
−5
Right Ascension (mas)
Map center: RA: 12 19 23.221, Dec: +05 49 29.795 (2000.0)
Map peak: 0.305 Jy/beam
Contours %: 1 2 4 8 16 32 64
Beam FWHM: 1.06 x 0.294 (mas) at −18.3°
0
0.05
0.1
0.15
0.2
0.25
0.3
Jy/beam


Spectral Index
2
1
0
-1
-2
-1
0
1
2
Distance from Peak (mas)
CORE
COUNTER-
JET
JET

CONCLUSIONS

A comparison of our 8, 22, and 43 GHz VLBA images indicates that the region just east of the radio core, including the first parsec of the counterjet, has a highly inverted spectrum. It is plausible that free-free absorption by gas in the central accretion disk is responsible. The jet and counterjet both have steep spectra far from the core, as expected.

Since emission from both the jet and counter-jet is detectable with VLBI, it may be possible to measure proper motions on both sides of the core. If so, the orientation of the radio jets with respect to our line of sight can be found, and residual relativistic beaming effects on the jet/counterjet brightness accounted for. A more sensitive 43 GHz VLBA image (where free-free absorption is minimal) can then be used to see how similar the jet acceleration and collimation processes are on both sides of a "central engine" at the same epoch.

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.